

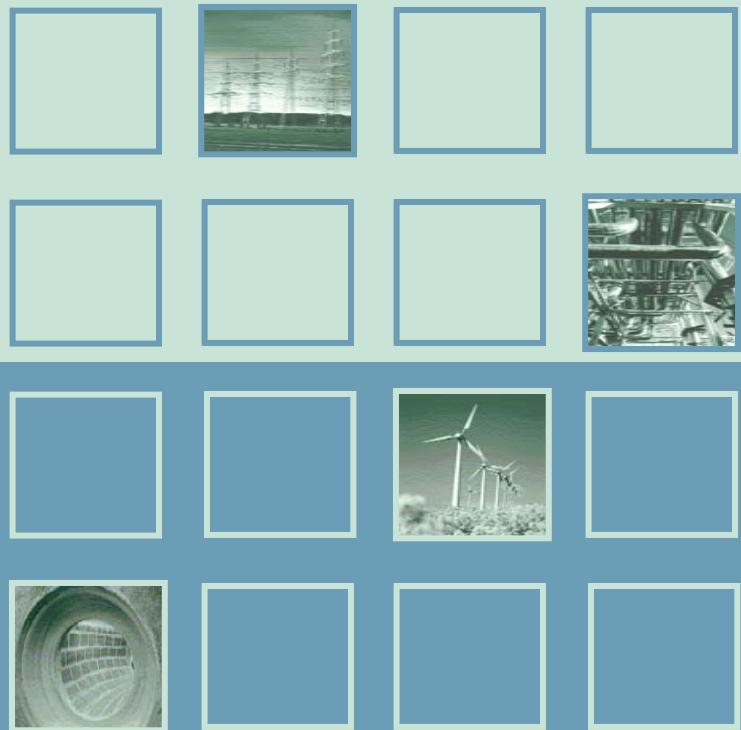
# Power & Energy Architecture for NZE Buildings: Thermal Management

February 3, 2009

Dr. Stephan Richter

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Germany

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# Who is GEF Ingenieur AG ?



GEF is an engineering and energy efficiency consulting and design company. GEF mainly focuses on district heating/cooling systems. GEF develops economic and energy efficient solutions in the field of energy supply, media transport and environment related technologies for our customers since almost 25 years.



GEF Office in Chemnitz, Germany

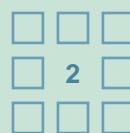
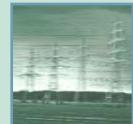
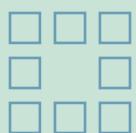


GEF Office in Leimen, Germany

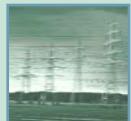
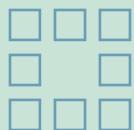
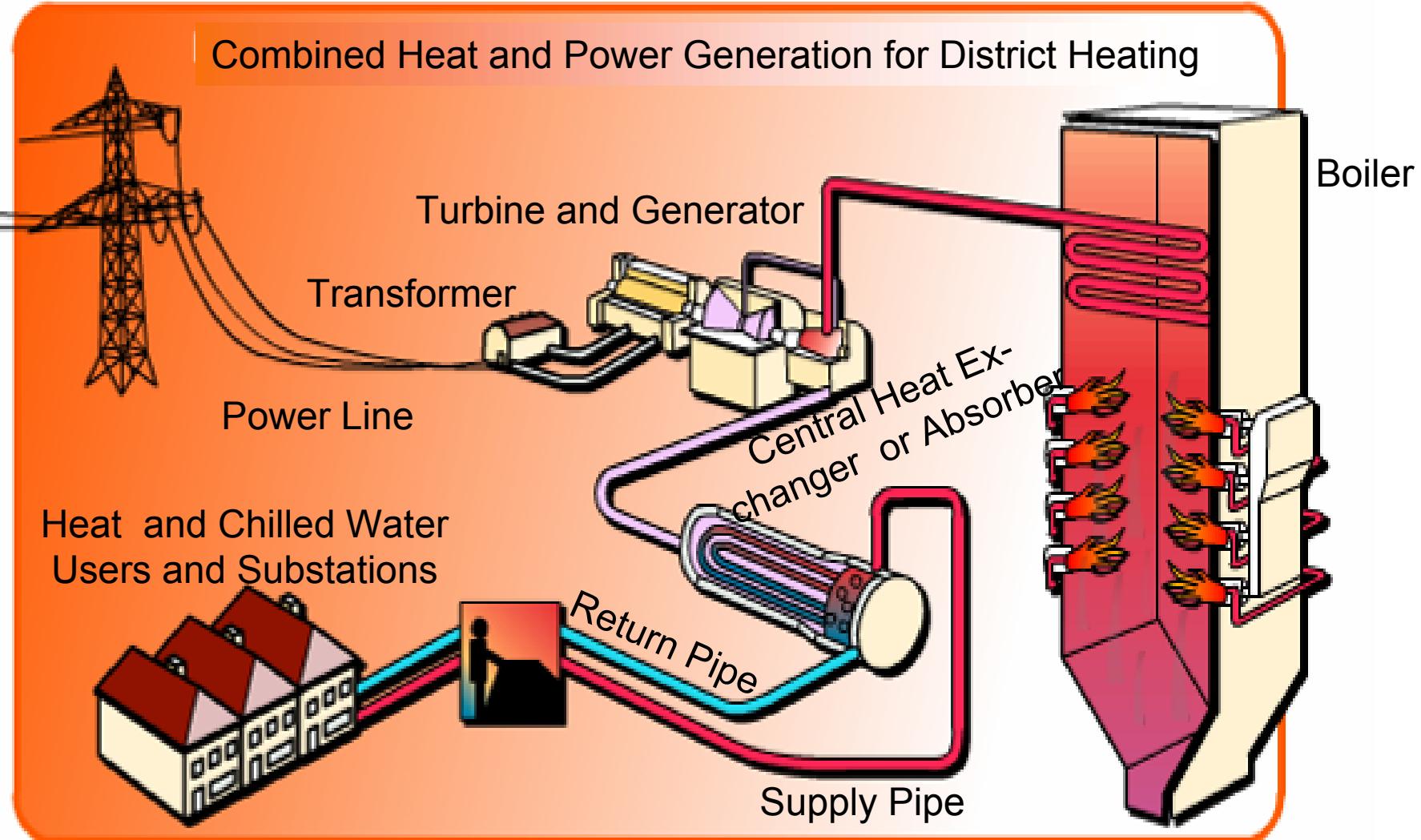
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Our neighbor ship in Leimen

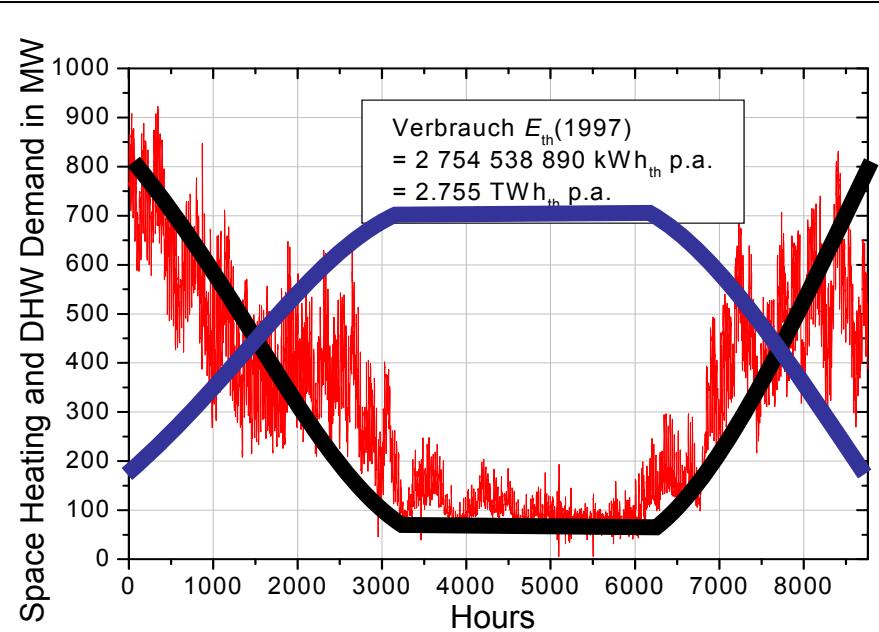


# Central Energy Systems at a Glance

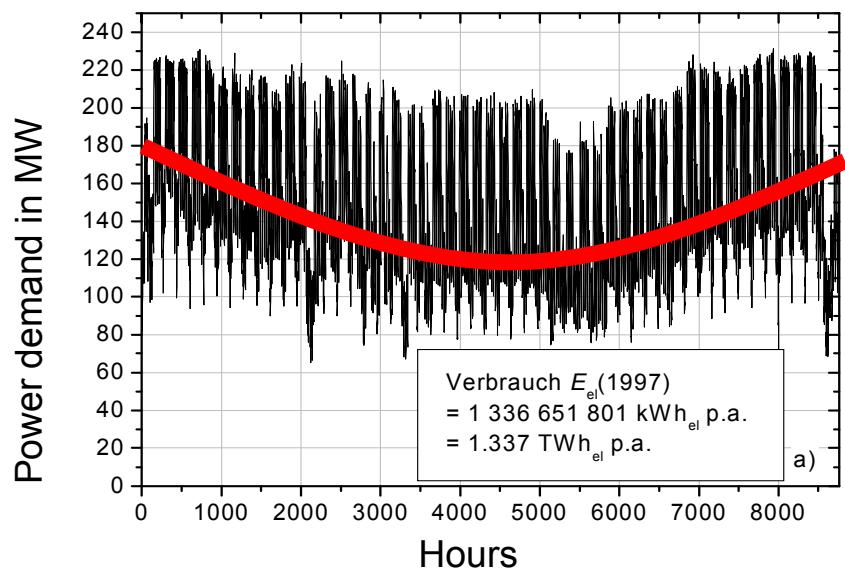


# Thermal Energy Demand

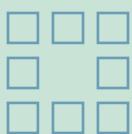
Space Heating and DHW



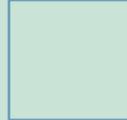
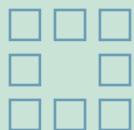
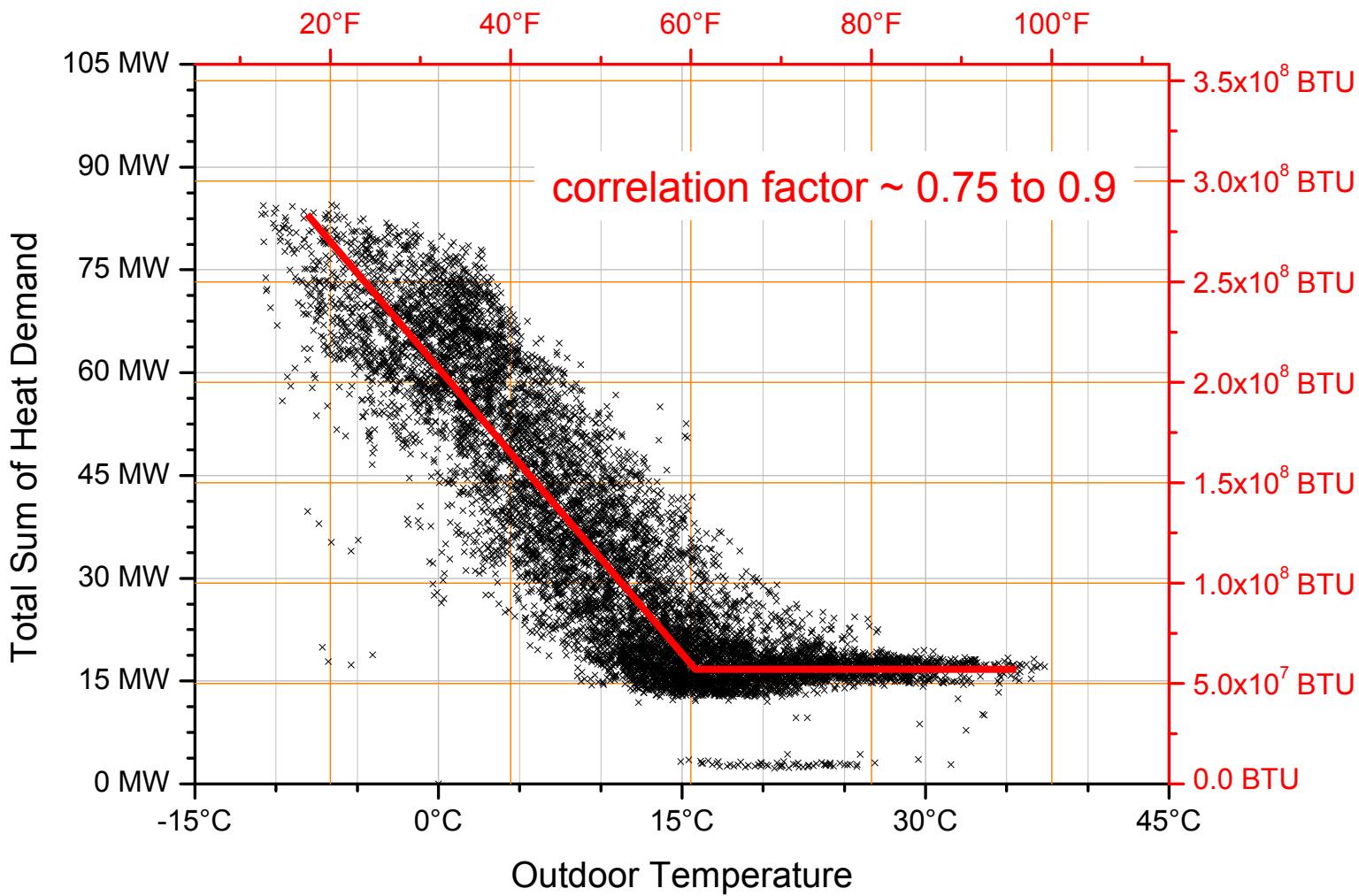
Electricity



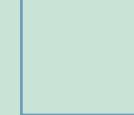
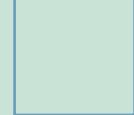
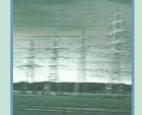
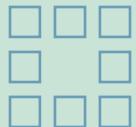
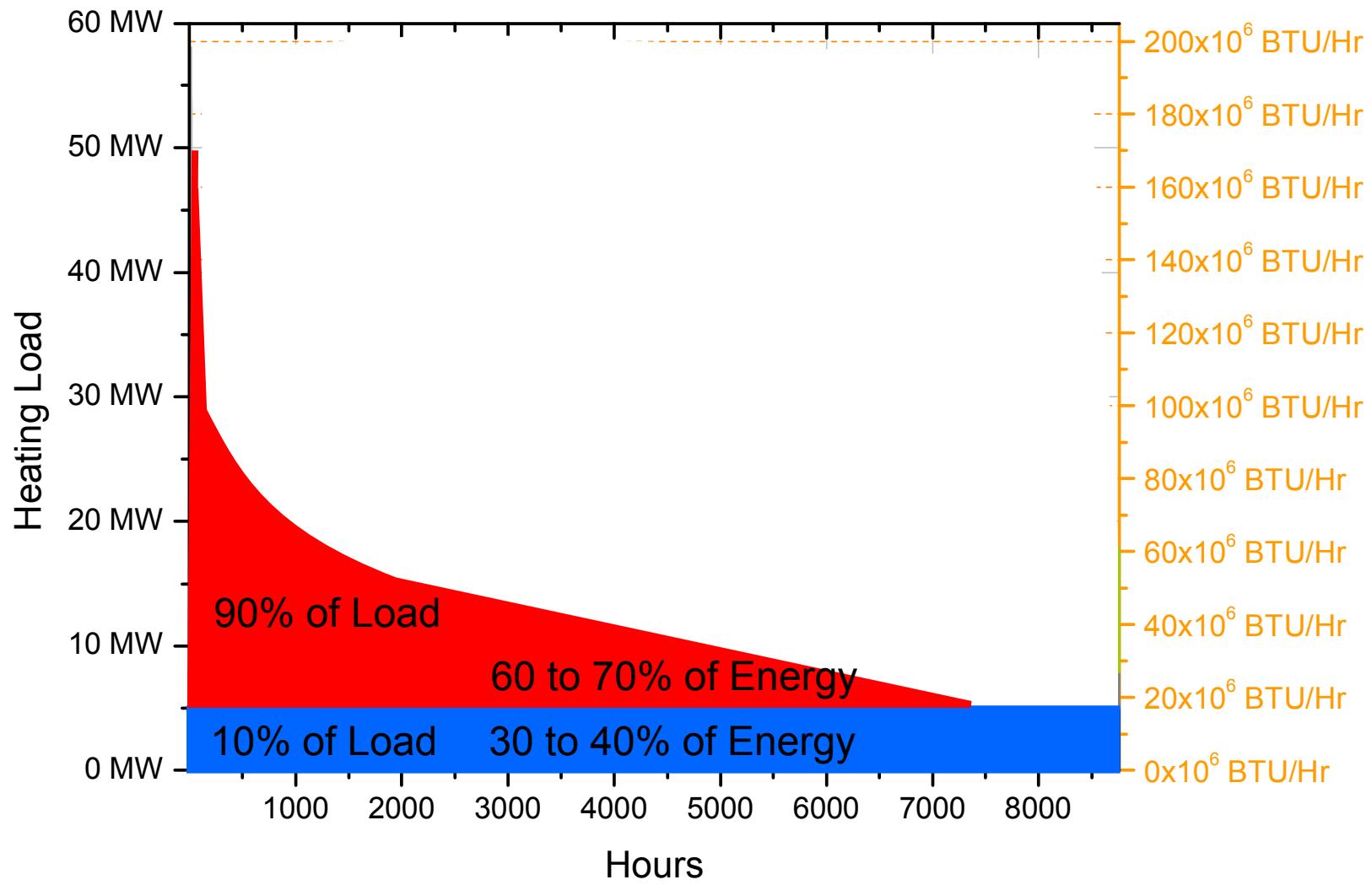
Air Conditioning / Cooling



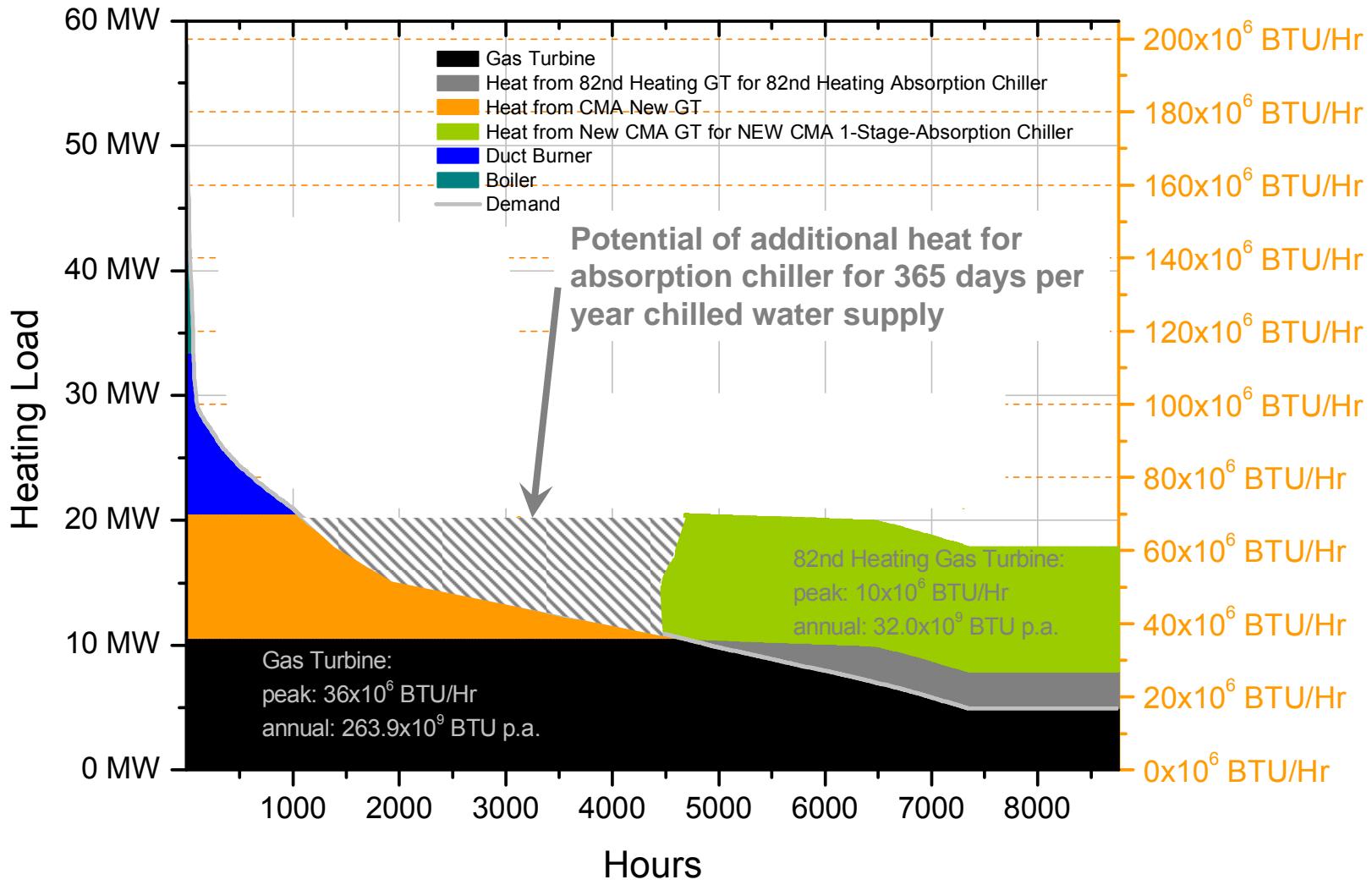
# Heat Demand Depends on the Ambient Temperature



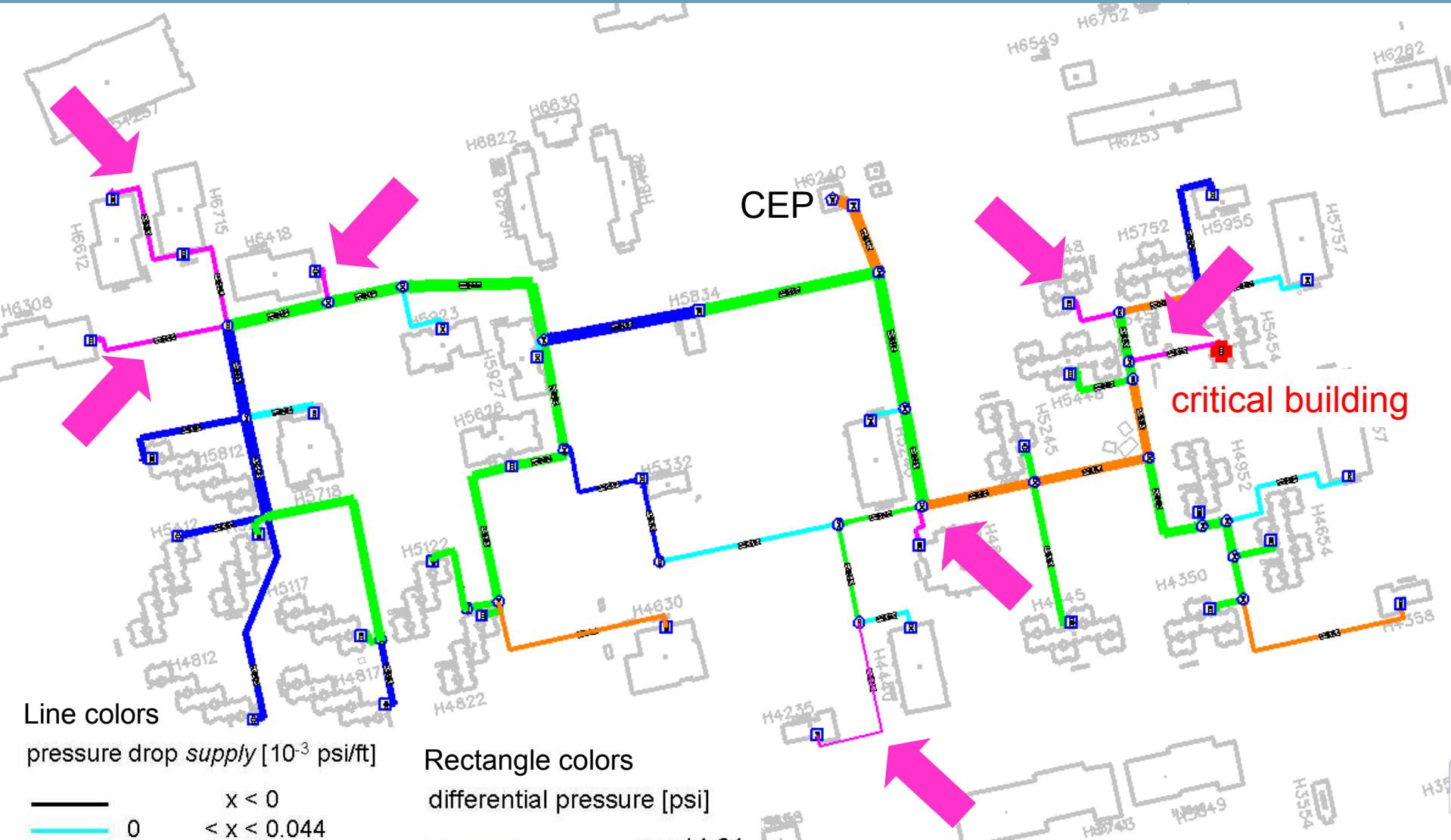
# Load Curve of a Central Heating Concept



# Heat Generation incl. Heat for Absorption Chillers



# Transport and Distribution System – Pressure, Temps and Pipe Sizes Determine the Capacities



Line colors

pressure drop supply [ $10^{-3}$  psi/ft]

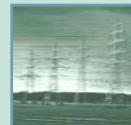
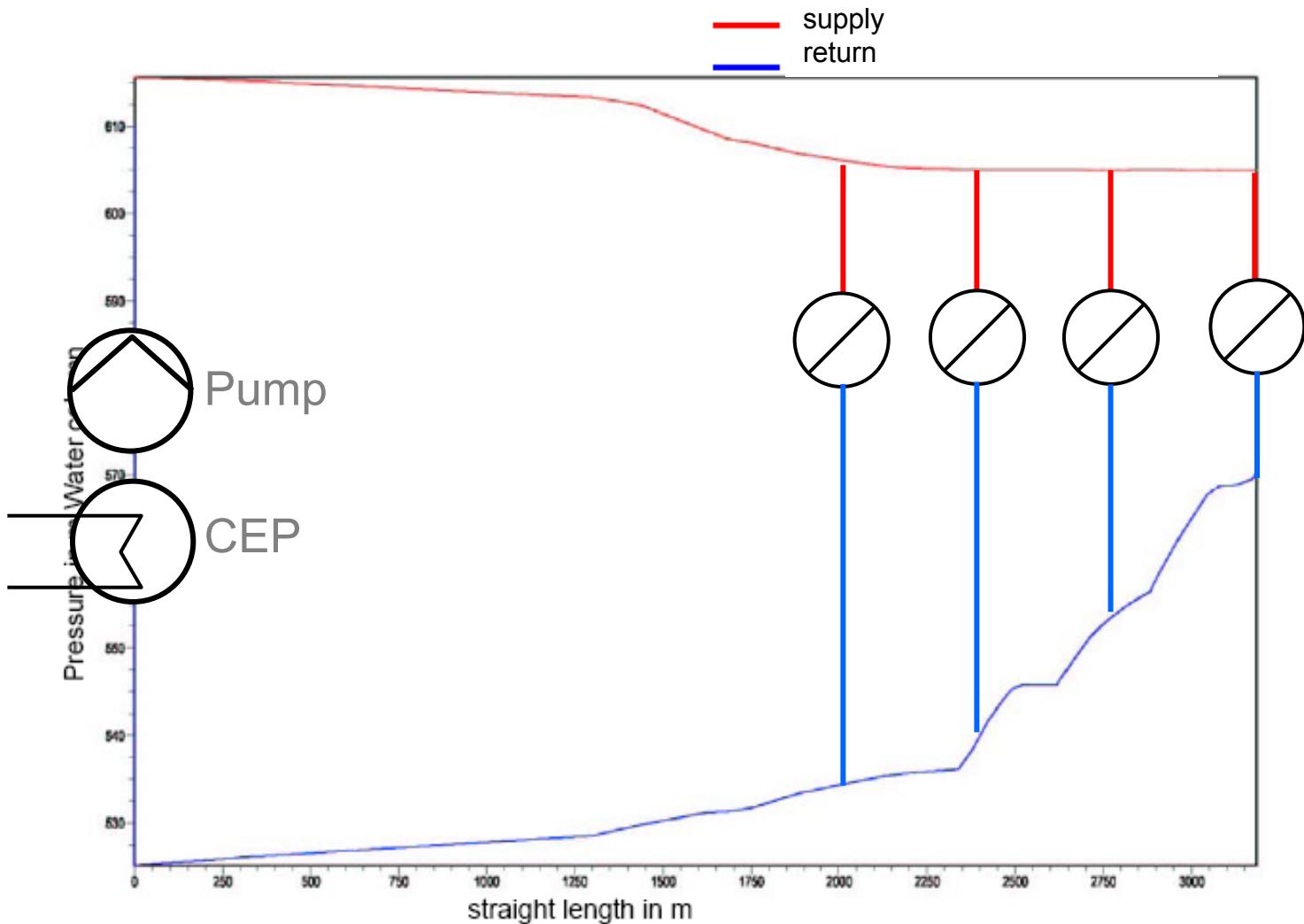
—	$x < 0$
—	$0 < x < 0.044$
—	$0.044 < x < 3.99$
—	$3.99 < x < 6.63$
—	$6.63 < x < 17.68$
—	$17.68 < x$

Rectangle colors

differential pressure [psi]

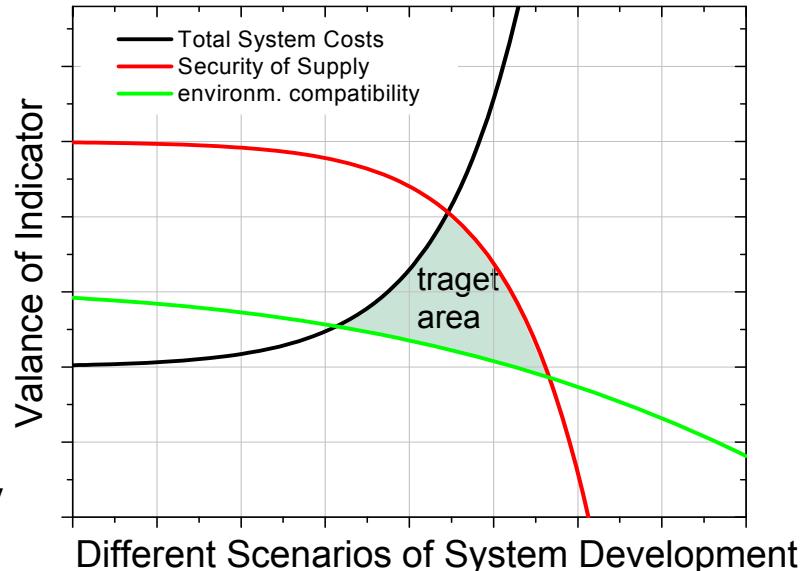
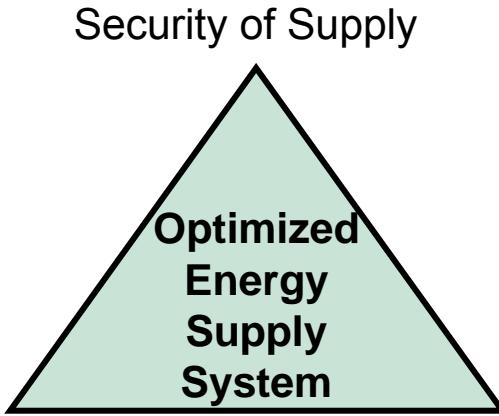
—	$x < 14.64$
—	$14.64 < x < 17.40$
—	$17.40 < x < 29.01$
—	$29.01 < x$

# Operating a Modern Variable Flow Hot Water System – Hydraulic Flow Analysis in Peak Load Case



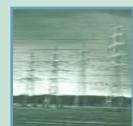
# Systematic Approach

The Problem can be described as a „classic“ Optimization Problem



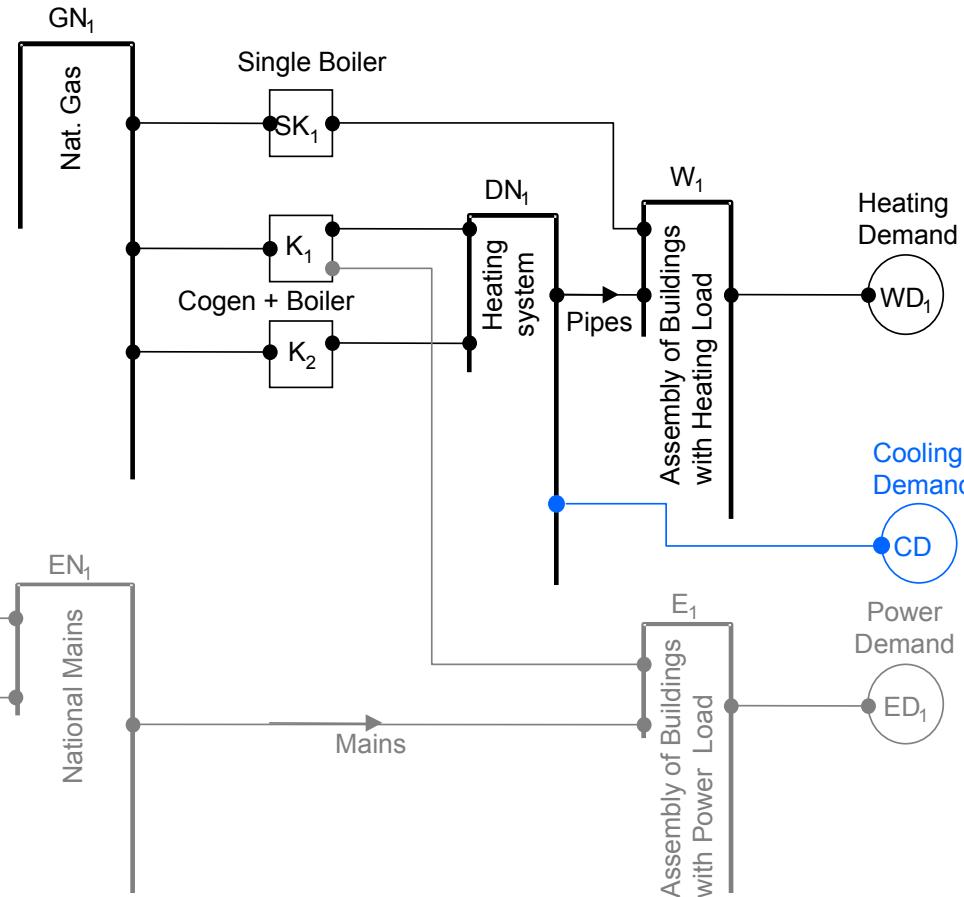
An energy system analysis tool can help to focus the hole Picture. But also the distribution system for energy itselfs needs to be considered carefully.

**POLIS** – Program package to Optimize Local Infrastructure Systems is an available tool to optimize “community” or “local” energy systems as a hole. POLIS is able to consider restrictions from a thermal distribution system



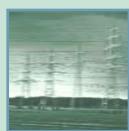
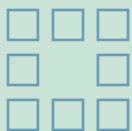
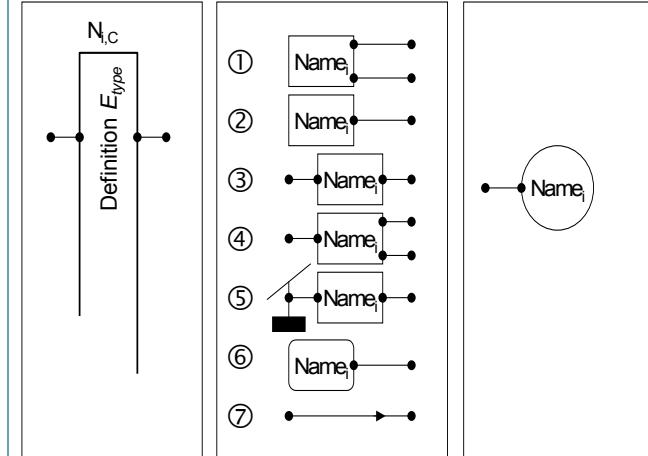
# Modelling the Hole Picture by Using POLIS as Tool for Energy System Analysis

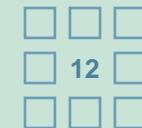
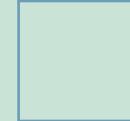
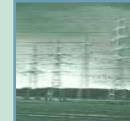
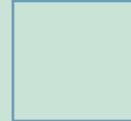
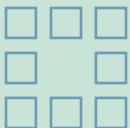
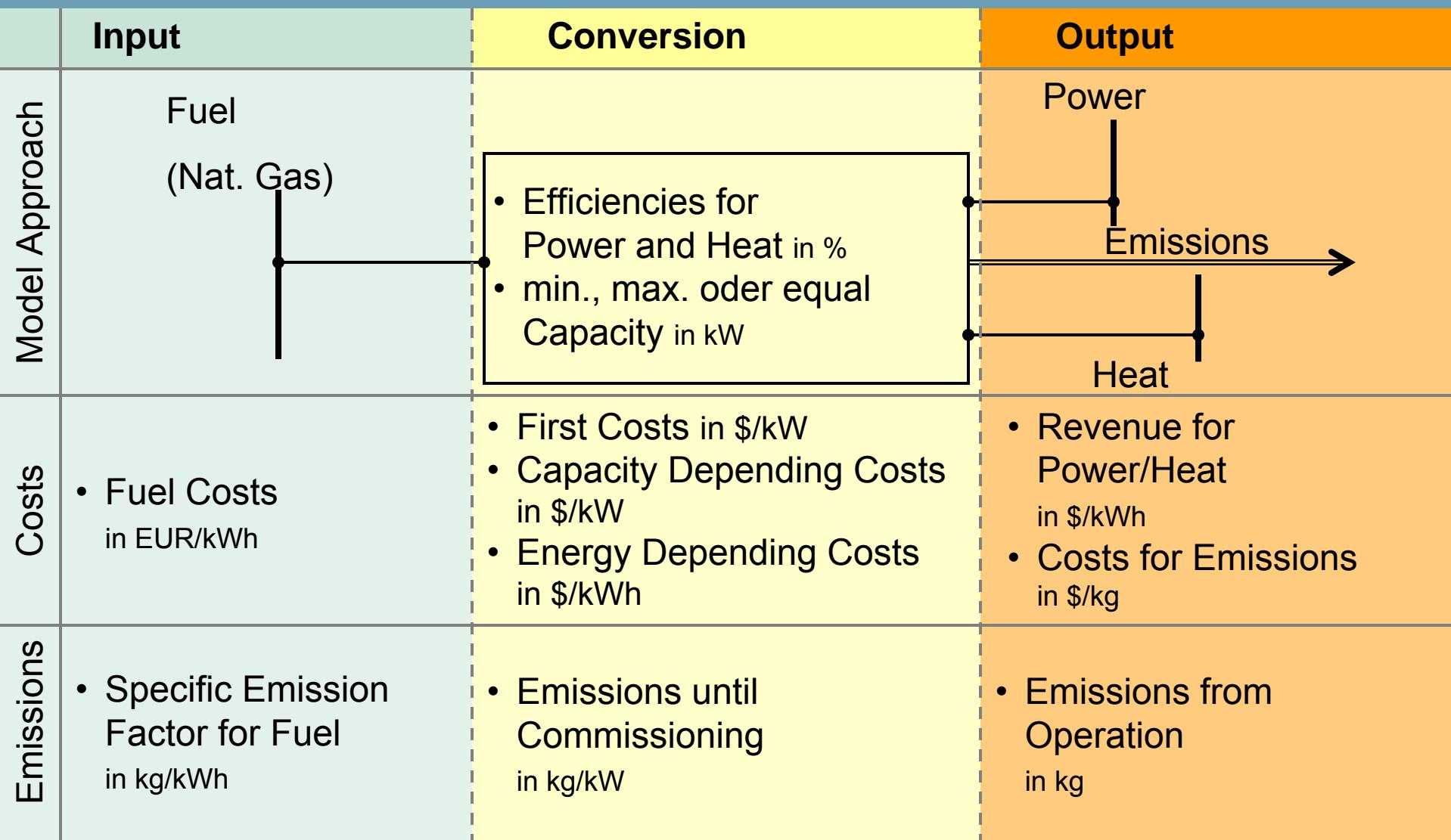
## Energy System



## Tool Box

Net Supply Options Demands





# Modelling an Entire System – Holistic Approach

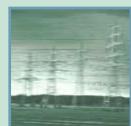
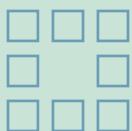
**POLIS** is best suited to model a more or less unlimited number of elements in an energy system. Therefore a small number of prototypes are required, which can stand for pieces of equipment. Thus a number of parameter describing technical and cost related attributes needs to be defined.

## Prototypes

- Power Plants
- Central Boilers, decentral Boilers
- Cogen/CHP-Plants
- Renewables
- Storages
- Networks

## Attributes

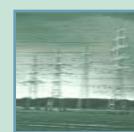
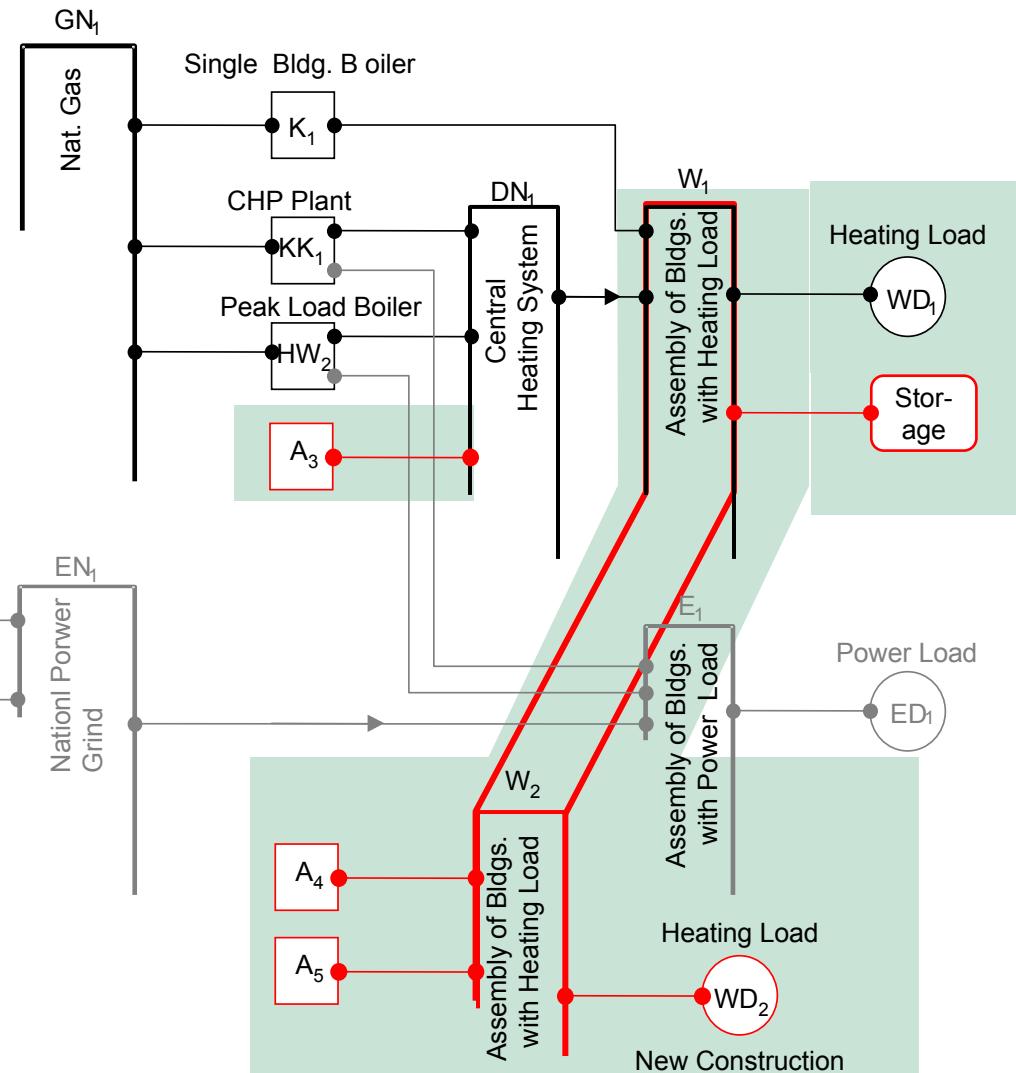
- Energy and Capacity Depending Costs
- Specific Emissions Before Commissioning and from Operation
- Fuel and its Attributes
- Existing Capacities



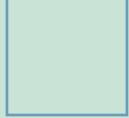
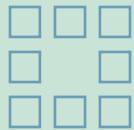
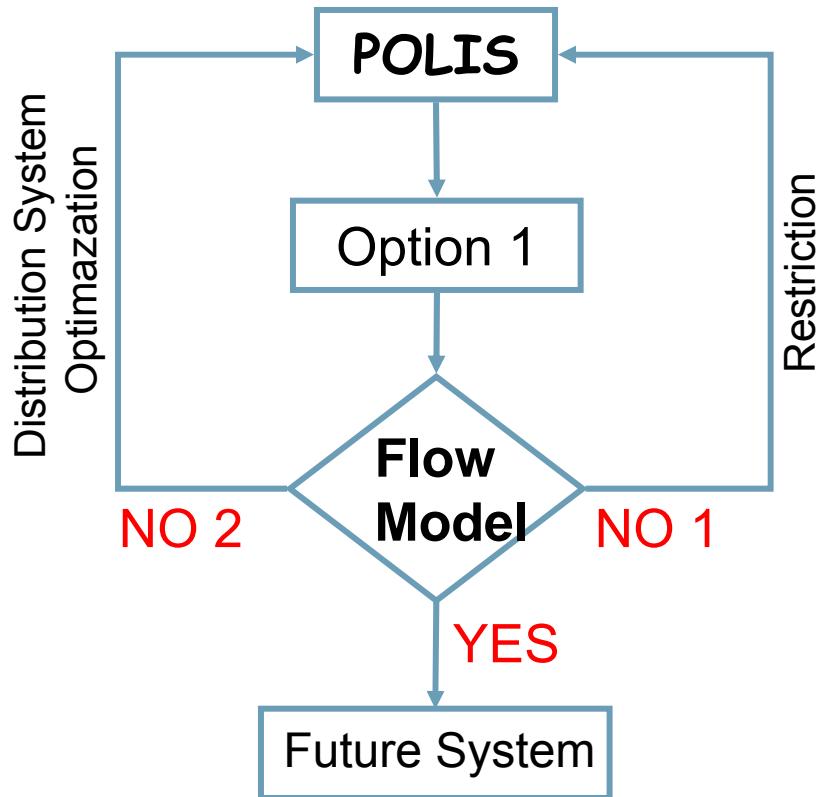
# Model and Optimize Future Systems Including Different Alternatives

## Alternatives

- New Supplies  $A_1 \dots A_n$
- Variations of Demands
- new (Primary) Networks
- Interconnections
- Storages
- ...

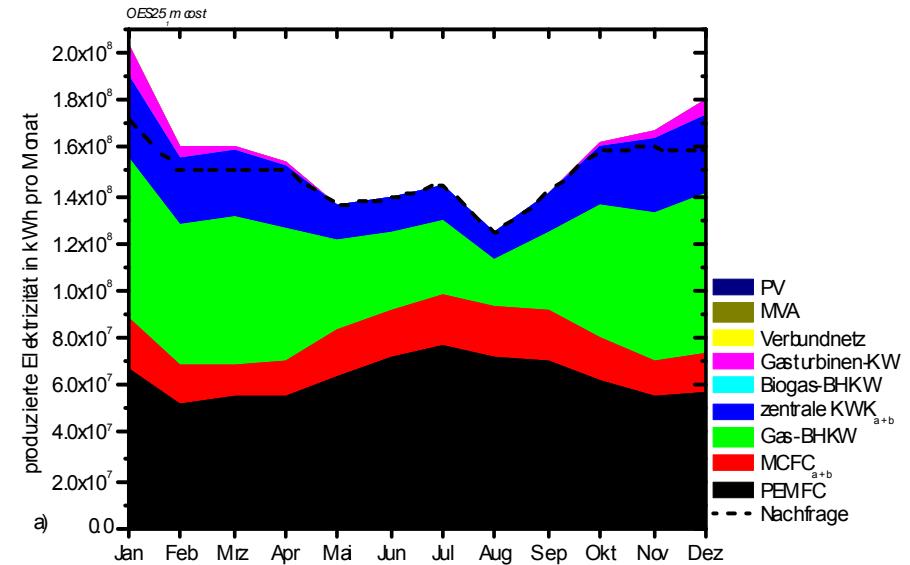


# Combination of Flow Modelling and System Analysis

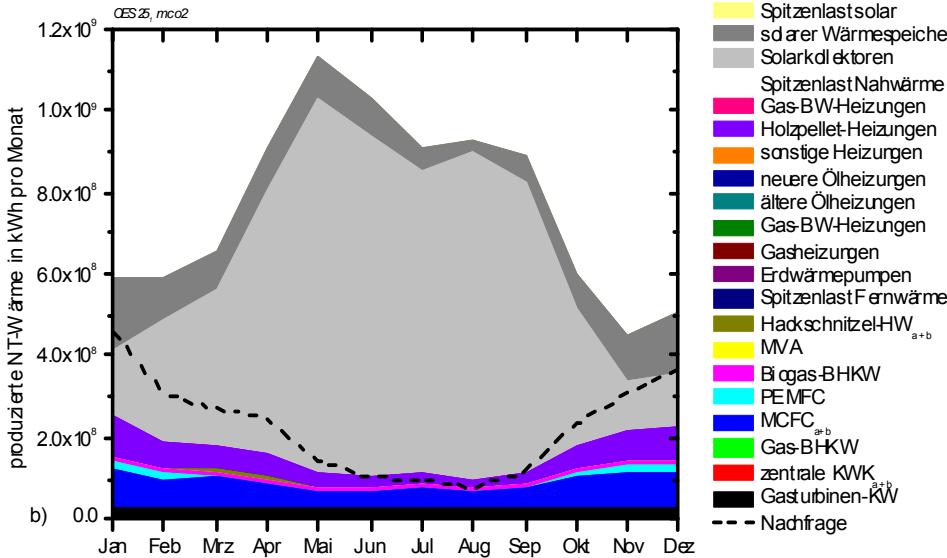
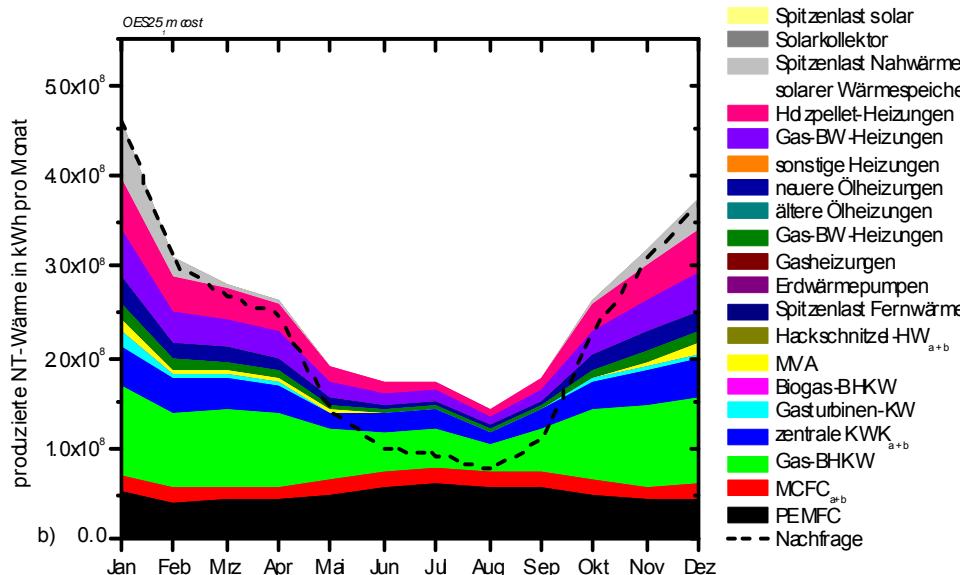
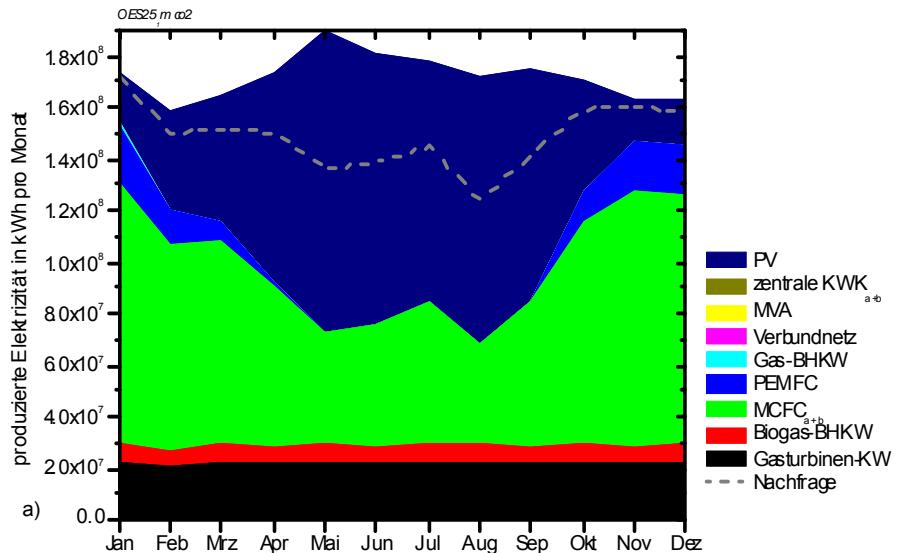


# Results Shown as Monthly Sums

## Cost Optimization



## CO<sub>2</sub> Optimization



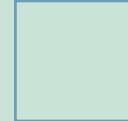
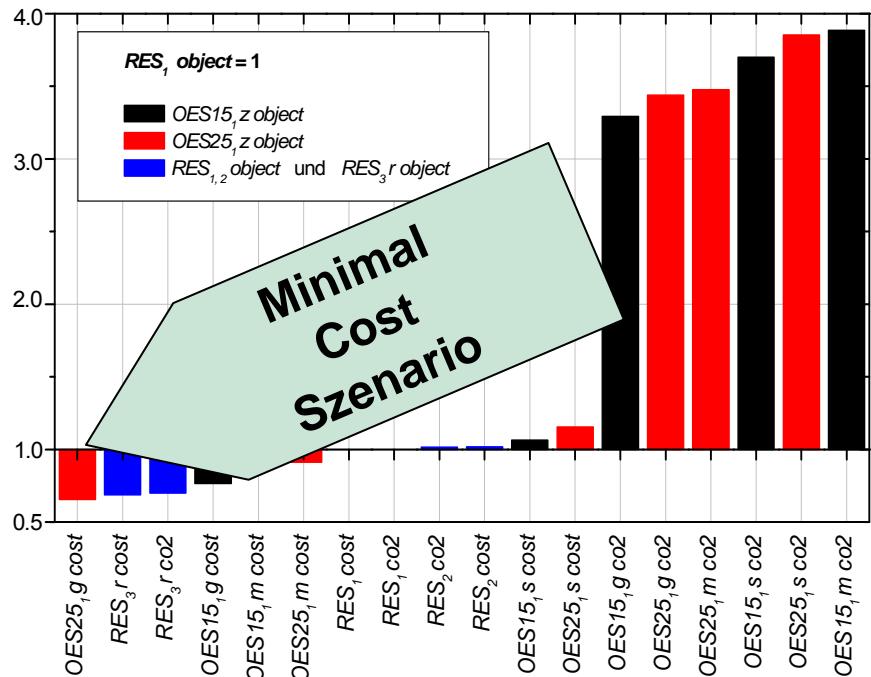
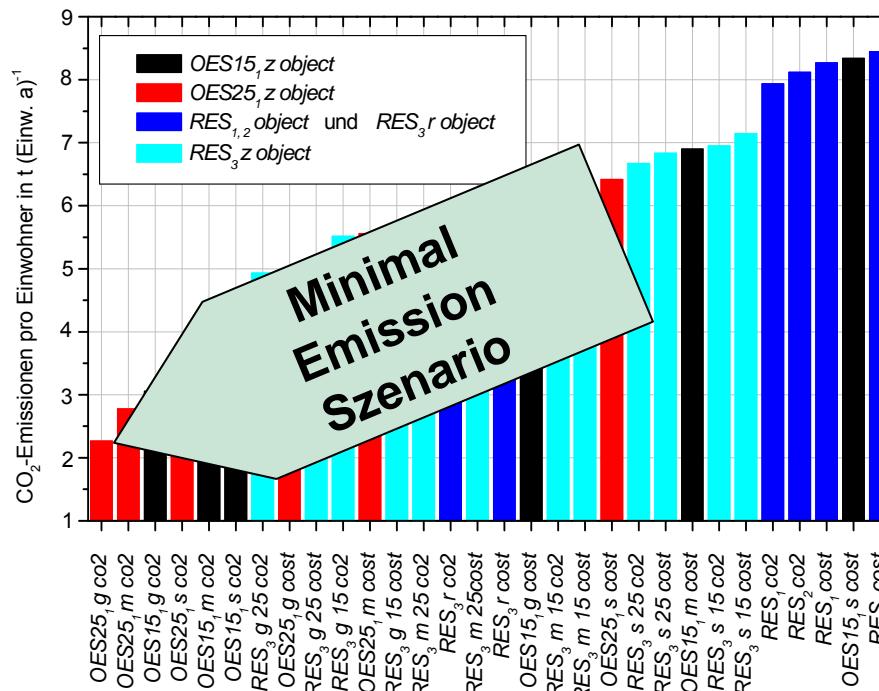
# Costs and Emissions Repercussion of Scenarios

Comparison of the resulting

## Emissions

and

## Total System Costs



- Differentiate between Measures on Demand Side, Supply Side and in the Distribution/Transport System
- Differentiate between New Construction and Existing Buildings
- Differentiate between Central Systems versus Decentralized Systems
  - What Fossil Fuel Replacement Costs are Going Around with a Measure?
  - What are the Costs for Minimizing the Load of Existing Buildings?
  - What are the Costs for Optimizing the Supply/Generation Equipment into a high Efficient System with Co-Gen and Tri-Gen?
  - What Size of the System is the best?
  - Where to Do what?

**We Need to Have a Look on the Hole Energy System  
Including the different Demands and Supplies and Sizes**

